PHONAK

A Sound Philosophy

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May 10, 1996

Mr. Reed Hundt, Chairman
Federal Communications Division
Washington, DC 20554

FCC MAIL ROOM

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FCC Proposed rule making for Auditory Assistance Devices (216-217 MHz band)
Docket 95/96, RM-7784

Dear Chairman Hundt,

Wireless (FM) auditory training systems and assistive listening devices are currently approved for use in the 72-76 MHz range. It is estimated that last year (1995) app. 27,000 such products have been sold. Of these 90% are used by children with learning disabilities caused by hearing loss. Potentially, over 1 million school children and 1'5 million adults with severe to profound hearing loss can benefit significantly from FM listening devices.

It is generally acknowledged, that benefits of 72-76 MHz FM systems are limited by interference. A variety of sources, i.e. pagers, cellular phones, emergency dispatch, radio/TV stations etc., use the same frequencies and cause significant down times. (See enclosure 1 - A Survey of the Use of Hearing Technology in Schools, Anderson et al, Educational Audiology Monograph 4/96). A significant improvement promises the intent to free up 20 new frequencies in the 216-217 MHz band for use with auditory trainers, published by the FCC on 5/16/95.

Phonak welcomes this FCC initiative and, like other manufacturers, has developed a product, which meets the published 216-217 MHz technical requirements. This product is called "MicroLink". In addition to the reduction in interference, MicroLink increases user acceptance due to miniaturization and improved design. FM receivers can now be coupled directly to BTE style hearing aids, thus eliminating unsightly, unreliable hard wire connections. External receiver antennas are no longer a requirement. Preliminary specifications of our new "MicroLink" product are included for your information.

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The MicroLink technology is already being marketed in Europe. Discussing this breakthrough technology with users, parents and professionals in the United States has shown immediate acceptance and interest to purchase.

Unfortunately FCC efforts to finalize the proposed new rules have come to a halt. We therefore are unable to finalize development on the 216-217 MHz version of MicroLink, file for testing and FCC/FDA approvals of the device and proceed with production.

Many individual parents, educators and organizations such as SHHH (Self Help for Hard of Hearing) have expressed their dissatisfaction about the delay in approving the new frequencies and pledged to support the effort to expedite the process.

Quick regulatory action is very much in the public interest, but especially in the interest of the many hearing-impaired persons who will benefit greatly with improved ability to communicate in schools, work and personal lives.

We would appreciate your guidance on a timeline very much. Thank you for your attention and your support for this important cause.

Sincerely
Phonak Inc.

Helmut Ermann
Vice Chairman

cc: Donna Sorkin, Self Help for Hard of Hearing
Carol Rogin, Hearing Industries Association
FCC, Dockets Management Branch

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MicroLINK

System description

MicroLINK is a wireless communication system for hearing impaired people. It consists of a small radio transmitter and a miniature radio receiver that is built into the audio-shoe which attaches to the hearing instrument.

With modern hearing instrument technology, hearing instrument users can hear well and communicate effectively in a broad spectrum of the quiet and noisy situations they encounter in their daily lives. For some hearing instrument users, the nature of their hearing loss and/or the complex acoustic characteristics of some environments they encounter require additional help.

For example, a person with a mild to moderate hearing loss who needs to communicate regularly with a work colleague across a noisy factory floor; a person with a severe hearing loss who attends lectures in large reverberant theaters where the speaker is at a distance. Both these people are likely to receive extra benefit from their hearing instruments in these places by using the MicroLINK FM-system. The MicroLINK FM-system is able to direct the voice of the speaker they want to hear directly into their hearing instruments.

The small radio transmitter's microphone is placed close to the signal, the hearing impaired person want to hear e.g. the conversation partner in a noisy car, the lecturer in an university course, or a colleague in the workplace. The speaker's voice is then sent via an FM radio signal to the small MicroLINK radio receiver, which is built into the audio-shoe which attaches to the hearing instrument.

The MicroLINK FM receiver can in this way be connected to the whole range of Phonak hearing instrument, and also be connected to older models of Phonak hearing instruments with the audio-input facility.

With a cosmetic appearance and a wide operating range, its features make it an option for almost limitless applications, e.g. business meetings, sports, schoolrooms and lecture theaters, places of worship, factories, for radio and TV, guided tours, the car and public transport, parties and social events.

MicroLINK is operating with narrow-band frequency modulation on frequencies permitted for this application by the authorities in the respective countries.

The transmitter operates with a fundamental mode quartz and a multiplier of the oscillator frequency. The MicroLINK receiver is of Superheterodyne-Type with one single intermediate frequency, and features a squelch circuit. The range of the system is depending on the environment, but is typical from 10 to 30 meters (30 to 90 ft). The MicroLINK receiver incorporates a built-in magnetic antenna which is sufficient for normal communication range. For extended range, 30 to 100 meters (90 to 300 ft) an external flexible antenna is available as an option.

The transmitter operate with a single AA battery cell; rehargeable nickel-cadmium or NiMH cell may also be used.

The MicroLINK receiver is powered from the hearing instrument's battery.

MicroLINK is manufactured by Phonak Communications Ltd. in Murten/ Switzerland, which is a subsidiary of Phonak AG in Stäfa, a leading hearing instrument manufacturer.

MicroLINK

Technical Specification

Frequency range:	169 - 230 Mhz
Frequency control:	Built in Quartz Crystal
Frequency stability:	Better than +/- 10ppm over the whole voltage and temperature range
AFC range: (Automatic Frequency Control)	+/- 5kHz
Type of modulation:	FM
Channel selectivity:	- 50 dB (at +/-150 kHz channel spacing)
Sensitivity:	SINAD > 15 dB at s mV/m
Signal-to-noise ratio:	> 45 dB (Fmod = 1 kHz, fdev = 3 kHz)
EMC:	As per Standard ETS 300445
Antennas:	Standard: built in magnetic antenna Option: External flexible antenna
Typical Range:	10 to 30 meters (30 to 90 ft) with internal antenna 30 to 100 meters (90 to 300 ft) with optional flex antenna
Power supply:	From the hearing instrument's battery
Current drain, with an audio signal > 20dB SINAD:	< 1.5 mA (1.2V) In standby mode < 30µA
Supply range:	1.0 to 1.6 Volt. Below 1V (empty battery) the output level is reduced to prevent instability
Audio frequency response:	flat 100 - 6000 Hz (- 3dB)
Total harmonic distortion at	< 2% (at 1 kHz AF/3 kHz deviation)
Working temperature:	0°C to +60°C
Size:	10 x 10 x 8mm (0.39" x 0.39" x 0.31")
Weight:	2 grams (0.07 oz)

A Survey of the Use of Hearing Technology in the Schools

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Peggy Benson, Ed.S.
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This survey was conducted in the fall of 1994 to obtain data about FM-interference problems experienced by educational audiologists. Additionally, the survey attempted to determine the extent to which hearing technology is used in the schools and patterns for its use. A questionnaire was mailed to all members of the Educational Audiology Association living in the United States (N=588). The return rate for the survey was only 12.9% (N=76) so the results cannot be generalized to all educational audiologists. Despite this, over 10,000 children with hearing impairments are represented, and the information obtained provides some interesting insights into the populations served by the educational audiologists, their use of various forms of hearing technology, and the problems with FM-signal interference they experience.

Within the past 10 to 15 years the use of hearing technology in the schools has proliferated. While educational audiologists recognize the benefits of this technology, most are faced with many problems implementing its use in the schools. One problem that has recently become a major concern is that of interference with FM signals, particularly with wide-band FM signals. The Federal Communication Commission (FCC) has allocated specific frequencies for educational FM transmission. In 1992, the FCC increased the number of frequency bands for FM-system transmission from 32 to 40 narrowband channels or from 8 to 10 wideband channels. While the allocation of these additional channels has helped, educational audiologists continue to experience interference with FM signals from a variety of sources.

In 1994, several organizations, including Self Help for the Hard of Hearing (SHHH) and Phonic Ear, Inc., petitioned the FCC, asking for more restricted access to the FM band used for educational purposes. The petition asked that this band be used primarily for low-energy users (i.e., devices for hearing impaired, bank security systems) and that the band currently devoted to riverboat traffic be reassigned. In order to provide objective data for the FCC, SHHH requested that the Educational Audiology Association (EAA) assist in documenting the magnitude of the FM-interference problem experienced by educational audiologists.

In the fall of 1994, EAA conducted a survey of its members living in the United States. While the primary focus of the survey was to provide the information requested by SHHH, EAA also attempted to gather information about educational audiologist's use of various types of hearing technology. Specifically, the purposes of the survey were: (a) to provide data about interference with FM signals experienced by educational audiologists and (b) to determine the extent to which hearing technology is being used by educational audiologists.

Reprint Requests: Karen Anderson, 15610 121st Avenue, Court E, Puyallup, WA 98374.

Method

A questionnaire, using both open and closed format questions to maximize the information obtained, was developed by the researchers with input from Mark Ross of SHHH. The questionnaire was divided into three sections, one seeking demographic information, one requesting information on the use of hearing technology, and one focusing on the FM interference problems encountered. The demographic questions related to the size of the school district and the number of students with varying degrees of hearing loss served by the educational audiologist. The questions on the use of hearing technology requested information about the use of personal FM systems, assistive listening devices (e.g., PockeTalker, Easy Listener), and soundfield FM amplification systems. The section on FM interference included questions on the frequency of FM interference, attempts to resolve these problems, and the effects of these problems on students with hearing losses.

The survey was mailed in November, 1994, to approximately 588 members of the Educational Audiology Association living in the United States. Due to the need to obtain responses quickly and to the limited funding for the survey, there were no follow-up mailings. Questionnaires were returned by 75 members from the United States and one person from Canada, providing a response rate of 12.9%. The 76 questionnaires received represented 125.4 full-time equivalent (FTE) positions in educational audiology. Although the response to the survey was minimal, and therefore, cannot be considered representative of the practice of educational audiologists in the United States, the information obtained from the questionnaire has been useful to SHHH and provides some information regarding trends in the use of hearing technology in the schools.

Results

Demographic Information

The educational audiologists who responded to the survey represented 33 states with no more than 6 audiologists responding from any one state. The states represented by the most audiologists were Illinois (N=6), California (N=5), New York (N=5), Ohio (N=5), Pennsylvania (N=5), and Washington (N=5). When the states were divided into 6 geographical regions, the greatest representation was from the Northeastern states (N=24) and the least representation was from the South Central states (N=4). Table 1 presents the geographical distribution of respondents.

Table 1. Geographical Distribution to Survey Respondents (N = 76)

Region	Number	Percentage
North Central (IA, IL, IN, MI, MN, ND, NE, SD, WI)	17	22.4
Northeast (CT, DC, DE, MA, MD, ME, NH, NJ, NY, OH, PA, RI, VT)	24	31.6
Northwest (AK, ID, MT, OR, WA, WY)	10	13.2
South Central (AR, KS, LA, MO, MS, OK, TN, TX)	4	5.3
Southeast (AL, FL, GA, KY, NC, SC, VA, WV)	9	11.8
Southwest (AZ, CA, CO, HI, NM, NV, UT)	10	13.2
Canada (BC)	1	1.3
No Response	1	1.3

The local education agencies or regional cooperative agencies served by the audiologists ranged in size from 1,200 students to 400,000 students with a fairly equal representation of different size districts. Ten audiologists served districts having fewer than 5,000 students, and 7 audiologists served districts with over 100,000 students. The distribution of the size of the agencies is show in Table 2. Nine of the survey respondents worked in schools for the deaf or in other special schools. The population of these schools ranged from 23 students to 420 students, with most having between 100 and 200 students. The total population served by the educational audiologists represented in this survey (N = 121.9) was 3,326,675, giving a ratio of 1 FTE educational audiologist for every 27,290.2 students.

The educational audiologists served a total of 10,688 students who were qualified for special education services primarily because of their hearing losses. This gives a prevalence of 0.32% of the total population who are qualified for special education because of their hearing impairments. Students with any degree of hearing loss, including fluctuating and unilateral hearing losses, numbered 17,205, giving a prevalence of 0.52% of the total sample. Although many of the respondents indicated that the figures they reported were their " best guess," the prevalence provided by the respondents is less than half of the 1.4% prevalence expected based on the figures provided by Matkin (Educational Audiology Association, 1992). The number of students with hearing losses served by each educational audiologist ranged from a low of 6 students to a high of 920 with an average of 78.6 students per FTE educational audiologist.

Table 2. Size of Educational Districts Served by Respondents (N = 63)

Size of District	Number	Percentage
< 5,000	10	15.9
5,000 - 11,999	7	11.1
12 ,000 - 24, 999	10	15.9
25,000 - 49,999	14	22.2
50,000 - 99,999	15	23.8
> 100,000	7	11.1

Students served by the educational audiologists had a wide range of hearing losses with 45.1 % of the students being classified as deaf and 54.9% classified as hard of hearing. When the data from students served in special schools were removed from the sample, 41.9% of the students were deaf and 58.1% were hard of hearing. Only 53 (69.7%) of the respondents attempted to provide the number of students with specified degrees of hearing losses. As can be seen in Figure 1, 32.4% of the students served by these educational audiologists had average hearing losses ranging from 41-90 dB HL, 26.1% had average losses between 21 and 40 dB HL, 29.7% had fluctuating hearing losses secondary to chronic or recurrent otitis media, and 11.8% had unilateral hearing losses.

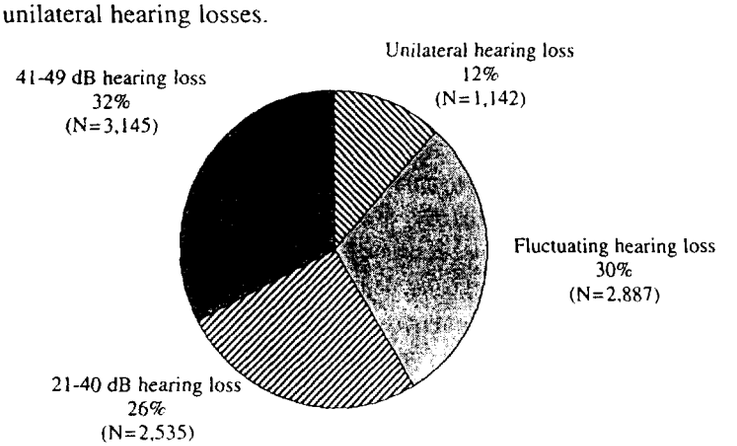

Figure 1. Students with Varying Degrees of Hearing Losses Served by Survey Respondents (N=9,709)

When the above data were compared with the expected prevalence figure provided by Matkin (Educational Audiology Association, 1992) as presented in Table 3, the prevalence of deaf students was slightly higher than expected (1.3 per 1000 reported; 1 per 1000 expected). However, when the reported data were compared to the expected prevalence for hard of hearing students, the reported prevalences were more than 3 times less than expected (2.2 per 1000 reported; 7 per 1000 expected). Similar underestimates were found for unilateral hearing losses (0.3 per 1000 reported; 2 per 1000 expected) and for fluctuating hearing losses

(0.9 per 1000 reported; 4 per 1000 expected). As was mentioned previously, these data must be treated with caution because they represent only a small sample of educational audiologists and because some respondents indicated that their data were estimates.

Table 3. Reported Prevalences of Hearing Losses Compared with Expected Prevalences*

Degree of Hearing Loss	Reported Prevalence**	Expected Prevalence**
Deaf (severe or profound sensorineural hearing loss)	1.3	1
Mild or moderate sensorineural hearing loss		7
Unilateral hearing loss	.3	2
Fluctuating hearing loss	.9	4

*Expected prevalence based on figures provided by Matkin (Educational Audiology Association, 1992)

**Per 1000 children

Note. There are some minor differences in the definitions of the categories for the reported data and for the expected data which may account for some of the discrepancies in prevalence figures.

Use of Hearing Technology

All but one of the 76 educational audiologists who responded to the survey indicated that some of the students with hearing impairments in their districts used hearing technology other than personal hearing aids in their classrooms. The number of students with hearing impairments using technology ranged from 0 to 350 with an average of 46.6 students per FTE educational audiologist. The percentage of students in each district using hearing technology other than personal hearing aids is shown in Figure 2. As can be seen, most districts had between 25% and 75% of their students with hearing losses using hearing technology in the classrooms.

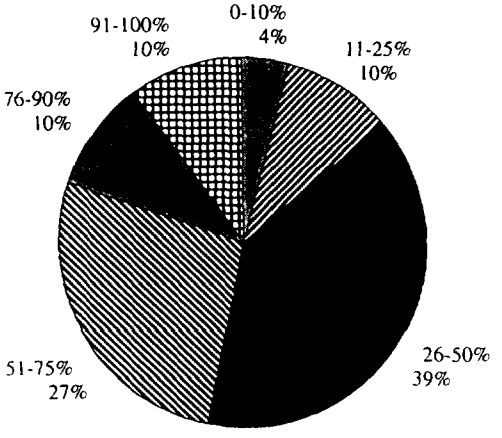

Figure 2. Number of Districts with Various Percentages of Students with Hearing Losses Using Hearing Technology in Classroom (N=71)

The total number of students using hearing technology other than personal hearing aids was 5,838, or 54.6% of the students with hearing impairments. Research describing the extent to which hearing technology is used in classrooms is very limited (Maxon, Brackett, & van den Bergf 1991), but it is felt that the technology currently available should be more widely used in order to improve students' access to information in their classrooms.

The most frequently used form of hearing technology for students with hearing impairments was personal FM systems. Such systems were used by 4,985 students, or 85.4% of all the students using technology. Personal assistive listening devices, such as the PockeTalker or Easy Listener, were used by 541 students (9.3%), and soundfield amplification was used by 717 students (12.3%). These figures total more than the total of 5,838 students reported above, possibly because some of the technology was used on students with normal hearing sensitivity.

Patterns of the Use of Hearing Technology. Although the data describing the use of personal assistive listening devices could not be statistically analyzed because the question was worded incorrectly on the questionnaire, there is some interesting information concerning the use of personal FM systems and soundfield FM systems by students. For the 4,903 students for whom data were provided, personal FM systems were primarily used in regular education (mainstream) classrooms 42.2% of the time (2,069 students) and primarily in special education classes 57.8% of the time (2,834 students). These data were not obtained for soundfield FM systems, but it is assumed that they were used primarily in regular education classes since many of these systems were used with students with normal hearing sensitivity.

Patterns for the use of hearing technology by students with varying degrees of hearing losses are provided in Figure 3. The data from one school district with 3,350 students with hearing losses were not included in this figure in order to avoid skewing the data. This district had a much higher than normal use of personal FM systems, especially for students with milder hearing losses. When the data from this school district was removed, less than 40% of the students in each hearing loss category used any form of technology. Personal FM systems were most commonly used for all categories of students, except those with fluctuating hearing losses. For these students, soundfield FM systems were more commonly used. Technology was used primarily with students who have permanent bilateral hearing losses (37.9% of deaf; 39.1% of hard of hearing). Only approximately 19% of the students with fluctuating and unilateral hearing losses used any form of technology, most often soundfield FM systems.

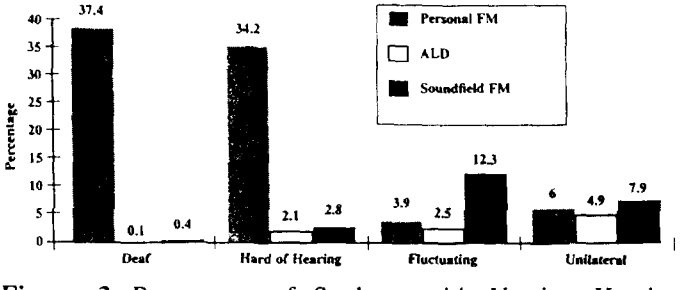

Figure 3. Percentage of Students with Varying Hearing Sensititivy Using Hearing Technology

Note. The data from one very large school district with a high use of personal FM systems, especially for milder hearing losses, was omitted to avoid skewing the data.

Use of Hearing Technology for Students With Normal Hearing Sensitivity. Recently there has been an increased emphasis on the use of hearing technology for students with attentional and/or listening or processing difficulties. Because no prevalence data were obtained in this study, it is not possible to determine the percentage of students with listening problems who were using hearing technology. However, the relative frequency of use of the various technologies can be reported. As can be seen in Figure 4, the most commonly used hearing technology for this sample was the soundfield FM system which was used for two-thrids of the students. Twenty-six percent of these students used personal FM systems, and 7% used personal assistive listening devices.

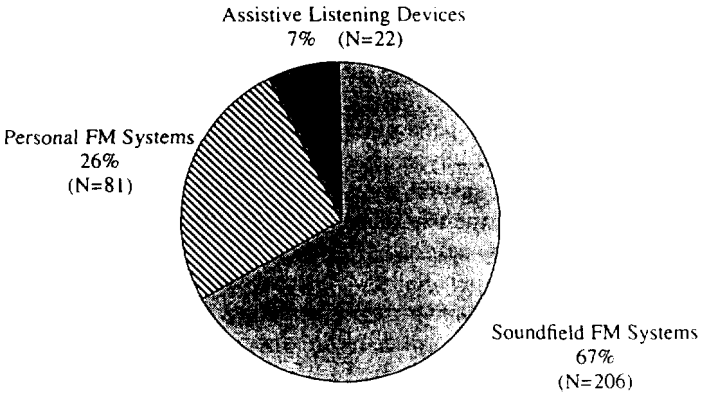

Figure 4. Percentage of Students with Normal Hearing Sensitivity Using Hearing Technology

Soundfield FM systems were also used in many classrooms which did not have children with identified hearing, attentional, or processing difficulties. The 58.6 educational audiologists who responded to this question used a total of 657 soundfield FM systems in such classrooms. While this yields an average of 11.2 soundfield systems per respondent, the number used by each district ranged from 1 to 200 with most districts using fewer than 10 units.

Approximatety 47% of the respondents in the total sample reported that soundfield FM systems were provided for students with identified auditory problems or for general classroom use. The data from 59.6% of the respondents indicated that there had been an increase in the use of soundfield FM systems during the past three years (since 1991-92 school year). However, when those not currently using soundfield FM systems were removed, 88.6% of the respondents indicated that there had been an increase. The average rate of increase for soundfield FM systems was 1.62 units per year.

Interference with FM Signals

The number of FM channels used in the school districts represented in this survey ranged from 1 to 40 with an average of 20.9 channels per district. The respondents were asked to identify how many clear FM channels they felt would be required to accommodate the potential use of FM technology in a large school. Although some of the respondents may have responded for their entire district rather than for just one school, the number of clear channels needed ranged from 5 to 50 with an average of 32.3.

Fifty-four (76.1%) of the respondents indicated that they had experienced some difficulty with FM signal interference. On the average, they reported that during the past three academic years, they had had 8.2 interference problems each year. The incidence of annual interference problems ranged from 0 to 150 with most respondents reporting 5 or fewer problems each year (See Figure 5). Two-thirds of the respondents indicated that problems with FM interference had become worse in recent years. When asked what specific FM channels were consistently affected by interference, most of the available channels were mentioned at least once. However, no educational audiologist had more than 8 narrowband channels nor more than 2 wideband channels which had persistent FM interference.

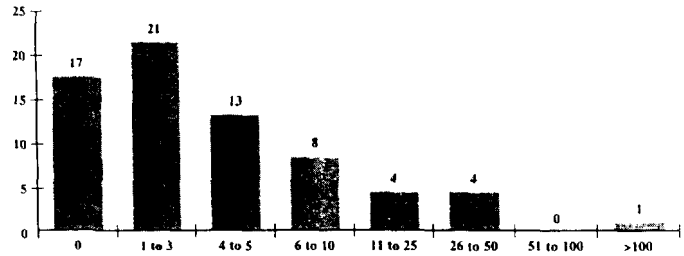

Figure 5. Number of Annual Problems with FM Signal Interference (N=68)

Thirty (62.5%) of the respondents were able to identify at least some of their sources of FM signal interference. The sources of interference were variable, with 8 of the sources being internal to the school and 64 being external. As can be seen in Table 4, the most common sources of interference were pagers, cellular telephones, and emergency services dispatchers.

Table 4. Frequency of Sources of FM Signal Interference

Source of Interference	Frequency Reported
Internal:	
Electronic equipment (computers, etc.)	4
Ceiling fan	1
Lights	1
Telephone	1
Other personal FM	1
External:	
Pagers	15
Cellular phones	11
Emergency dispatchers (police/fire/emergency)	10
Radio/television stations	7
CB/Ham radio transmissions	6
Other dispatchers (taxi, bus, truck)	5
Two-way radios	5
Baby monitors	2
Airport	1
Garage door opener	1
Electronic equipment (MRI)	1

In order to resolve the FM-interference problems, the educational audiologists used a variety of strategies as illustrated in Figure 6. The most common strategies used were to exchange the equipment with other equipment in the district to use channels that were problems in some areas in different locations (84.9%)

and to return the equipment to the company for a change in the FM channel (64.2%). Only 8 respondents (15.1%) had tried to work with their community's sources of interference. Using these techniques, the educational audiologists were relatively successful in resolving the FM-interference problem. Twenty-eight respondents (58.3%) indicated that they were successful 95% or more of the time, while only 3 respondents (6.3%) indicated success less than 50% of the time. The average success rate of the educational audiologists was 82.7%. Of the 8 educational audiologist who had tried to work with the community to resolve the interference problem, one was partially successful.

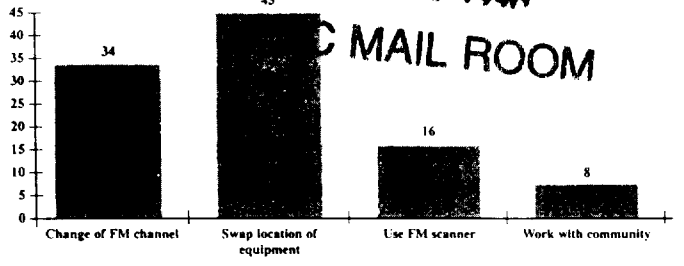

Figure 6. Strategies Used to Resolve FM Signal Interference Problems (N=53)

While the respondents were typically successful in resolving the FM-interference problems, there was considerable "down time" while the problems were being resolved. As shown in Figure 7, only 18 of the 58 educational audiologists (31%) typically resolved the interference problems within one day. An additional 13 educational audiologists (22.4%) indicated that problems typically were resolved within 3 days, but almost half of the districts represented had students who were without their FM systems for more than 3 days. Five respondents (8.6%) indicated that their students were typically without their equipment for more than 2 weeks.

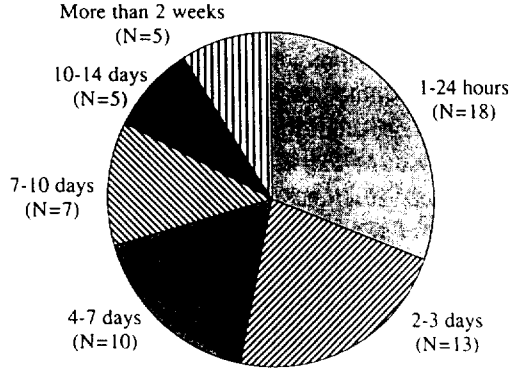

Figure 7. Average Length of "Down Time" with FM Signal Interference Problems (N=58)

When FM interference was present, several strategies were used to address the educational problems. Frequently students without FM equipment used only their personal hearing aids if appropriate (61.8%). FM loaners were available from the school district for 27 of the districts (49.1%) and from the manufacturer for 6 of the districts (10.9%). In 17 of the districts (30.9%), the student continued to use the FM system until a solution was found.

Regardless of the length of "down time," the educational audiologists frequently commented on the negative effects of the FM interference. FM interference made fitting a child with an FM system impossible for 12 of 49 respondents (24.5%). For these 12 respondents, only a small number of students were involved, ranging between 1 and 10 with an average of 2.4 students. But these students had limited access to auditory information in the classroom and their education was potentially adversely affected.

When asked to comment on reactions to the FM-interference problems, the educational audiologists provided a wide variety of experiences (See Appendix). Some reported that students, particularly older ones, were happy to be without the FM system, but others found that the students were lost and confused in the classroom. Teachers were generally frustrated by the problems they experienced and by the time it took to resolve the problems, and some were upset when the FM system was not available. Quite a few of the educational audiologists commented on the difficulty they had reestablishing consistent FM usage with both students and teachers when the FM-interference problem was resolved. Parents were typically upset by the "down time," and some reportedly complained to administrators about the problems.

Summary and Conclusions

This survey was undertaken by the Educational Audiology Association to provide objective data about interference with FM signals experienced by educational audiologists in order to support requests to the Federal Communication Commission (FCC) to provide more restricted access to the FM band used for educational purposes. Additionally, the survey was designed to determine the extent to which hearing technology is being used by educational audiologists. Since only 76 members (12.9%) responded to the survey, the results cannot be considered truly representative of the practice of educational audiologists in the United States. However, the survey provides the largest source of data currently available on these two issues, and, as such, is quite valuable. The survey results were presented to the Self Help for Hard of Hearing (SHHH) Technical Committee in February, 1995, and this information was communicated to the FCC. With the help of these survey results, the FCC made a decision in May, 1995, to make the 216-217 MHz band available to a new low-powered radio service (LPRS) which includes auditory assistance devices.

The information obtained from the survey indicated the following:

1. Each FTE educational audiologist represented by this survey served an average school age population of 27,290.2 students, including an average of 78.6 students with hearing losses. This is more than twice the ratio of 1 educational audiologist for every 12,000 students recommended in ASHA's Guidelines for Audiology Services in the Schools (ASHA,1993).

2. The prevalence of students requiring special education with hearing loss as the primary handicapping condition was 0.32%, and the prevalence of students with any type or degree of hearing loss was 0.52%. This is less than half of the expected 1.4% prevalence, based on the figures provided by Matkin (Educational Audiology Association, 1992).

3. Only 70% of the respondents provided information as to the type and degree of the hearing losses of the students they served, but this information indicated that the prevalence of deaf students was slightly higher than expected and that the prevalence of all other hearing losses was more than 3 times less than expected (Educational Audiology Association,1992). It therefore appears that hard of hearing students, including those with bilateral sensorineural, unilateral, and fluctuating hearing losses, were greatly under-identified. The slight over-identification of deaf students was likely due to the fact that 13.9% of the deaf students were enrolled in schools for the deaf where the majority of the population was deaf. The extreme under-identification in all of the hard of hearing categories represents a major concern for educational audiologists at this time.

4. All but one of the 76 respondents indicated that they had students with hearing impairments in their districts who used some form of hearing technology other than personal hearing aids. Almost 55% of the students with hearing losses used either personal FM systems, personal assistive listening devices, or soundfield FM systems. Use of some type of hearing technology would likely be beneficial to many of the students with hearing losses who are not currently using such technology.

5. Each educational audiologist monitored an average of 46.6 students with hearing impairments using hearing technology other than personal hearing aids. Although funding for technology is an issue when increasing its use, the number of educational audiologists available to fit and monitor the equipment also must be considered. There are no data in the literature that suggest how many students using hearing technology can be effectively monitored by a single educational audiologist. With the number of inservices and repairs needed to keep equipment in use and functioning properly, it is likely that many of the educational audiologists who responded to this survey could not monitor more equipment without additional support from another educational audiologist or a paraprofessional.

6. Personal FM systems were the most frequently used form of hearing technology used for students with hearing impairments, followed by soundfield FM systems and then personal assistive listening devices.

7. Personal FM systems were used primarily in special education classes 57.8% of the time and in regular education (mainstream) classes 42.2% of the time. While personal FM systems are useful in special education settings, these classrooms are typically smaller and the need for the FM system to provide accessibility is not as great as in mainstream classrooms. Students in regular education settings could likely benefit from wider use of hearing technology.

8. Hearing technology was used by 37.9% of deaf students and by 39.1% of hard of hearing students, but only by approximately 19% of students with fluctuating and unilateral hearing losses. While not all students with hearing losses will benefit from technology, it is obvious that hearing technology in the schools is under-utilized for all categories of hearing losses.

9. Soundfield FM systems were used by 206 students with attentional and/or listening or processing difficulties and was the most commonly used form of hearing technology for these students. Although no prevalence data were reported for these students, it is suspected that hearing technology is under-utilized for this population also.

10. Soundfield FM systems were also used in 657 classrooms without students with identified auditory problems. Most respondents used fewer than 10 systems in such classrooms, but there was an indication that the use of soundfield FM systems was increasing. The increase was primarily for those educational audiologists who were already using this technology. It, therefore, seems that audiologists who are using this form of hearing technology feel that it is beneficial and are working to expand its use in their districts.

11. FM signal interference was a problem for three-fourths of the respondents to the survey. They had an average of 8.2 interference problems each year and felt that the problems had become worse in recent years.

12. Most of the sources of FM interference were external to the schools with pagers, telephones, and emergency services dispatchers being the most common sources of interference. These are areas in which the educational audiologist has little control, and the few who had attempted to resolved these problems were unsuccessful.

13. Most of the educational audiologists indicated that they were eventually successful in resolving the FM-interference problems. The strategies they used typically involved a modification in the location of the equipment or in the FM frequency being used.

14. Despite the success in resolving the FM-interference problems, the educational audiologists reported that the problems negatively impacted the student's education because of the "down time" experienced. This " down time" was more than 3 days for almost half of the students. During this time the students' and teachers' reactions were varied, but in general there was a great deal of frustration because of the FM-interference problems.

This survey has provided a great deal of information about the use of hearing technology in the schools and about the FM-interference problems experienced by a small number of educational audiologists. While this information is useful in determining trends, similar information is needed from a larger population in order to generalize the results to all educational audiologists in the United States. It is hoped that future research can focus on defining the use of hearing technology in the schools and the problems associated with its use more completely.

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Appendix

Educational Audiologists' Comments Concerning Reaction to FM Interference (N=37)*

1. Students accept without much comment. Teachers may be anxious for return of FM.
2. Negative reaction from teachers, not students, is our greatest problem.
3. FM interference is most aggravating to mainstream students, and that's where the interference problems occur; not to deaf students!
4. Students use their personal hearing aids.
5. Most of the children are glad to be without the units.
6. Parents become upset and start calling administrators.
7. The older students are thrilled; the younger students are lost.
8. We've been able to keep down-time to a minimum, but even a few hours can cause frustration to audiologist, student, and teachers.
9. Reaction varies depending upon reliance on equipment.
10. Teachers/students seem to adapt well (hearing aids only for a day or two). Impact seems minimal, although some express disappointment.
11. Most students are pleased with down-time; reaction from teachers is mixed (relief, frustration); parents are supportive.
12. With any down-time I see students decrease in their independent functioning in the classroom and increase in dependence on the teacher for repetition, clarification, reteaching.
13. Students cannot receive instruction adequately; they are distracted; at times even the entire class is disrupted.
14. Frustration for student and teacher. Causes disruption over an extended period as the problem is usually intermittent. if either student or teacher don't see the value of FM, it can provide the excuse to sop using FM altogether.
15. Interference has been a successful excuse for students to not wear their FM systems. Teachers burdened by continual problems. Could we be teaching little ones to tune out due to unclear signals?
16. In the few cases of down-time, children either keep asking for FM or become more resistant to wearing the FM when it returns.
17. Students are often pleased—don't like stigma. It is then very difficult to achieve user and teacher acceptance when the problem is resolved.
18. Most are happy to lose the FM. A couple actually miss it—these kids always receive a loaner unit.
19. Students are reluctant to continue wearing even after FM is fixed. Teacher gets out of habit of wearing FM and hard to reinstate use.
20. Use personal hearing aids.
21. There is extreme frustration on the part of the student, classroom teacher, and audiologist. Amount of audiologist's time dealing with the problem has been excessive.
22. Down-time is very frustrating for student and teacher.
23. Parents upset about it. Lack of motivation to use unit when it returns.
24. Extreme frustration by teachers—some cases where teacher and/or student abandons FM.
25. Children frequently complain about the interference and are distracted by it.
26. Teacher irritated with interference through soundfield FM unit. Student frustrated by personal FM interference and time needed for repair.
27. Students not particularly bothered due to severity of hearing loss (Deaf School).
28. Student will notice static/interference, and the class will usually stop.
29. Frustration! Students blame the FM system. Equivalent to missing those days of school for many children.
30. If a student does not get an FM loaner, he will eventually lose interest in using it. Student's lack of motivation to resume FM use may affect educational performance.
31. Teachers and students rely on the audiologist to locate an FM channel that can be used in their school building.
32. Students are less responsive; teachers exasperated.
33. Detrimental! Students often have a hard time describing problem when interference is intermittent. Hard to catch.
34. Children sometimes become upset (especially in the mainstream) and so do their parents!
35. Teachers very frustrated. More oral students were bothered by it; wanted to take off equipment even if they needed it in the mainstream.
36. Students are distracted and confused. At least once a week a class comes to a halt because the teacher cannot use the FM. Management of interference occurs and disrupts each day.
37. Many students have learned that they can manipulate a frustrated teacher into allowing them to go without their FMs by claiming interference. The effects on students and teachers vary. Some are very upset, and others are elated at not having to use a device that they hate wearing.

*Some of the comments have been abbreviated.